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FROM THE AUTHOR.

THE

# ETIOLOGY AND PROPHYLAXIS

OF THE

# TUBERCULOUS DISEASES.

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[REPRINTED FROM THE MEDICAL NEWS, JUNE 8, 1889.]

# THE ETIOLOGY AND PROPHYLAXIS OF THE TUBERCULOUS DISEASES.

Being the Address in Medicine before the Medical Society of the State of Pennsylvania, at its Thirty-seventh Annual Session, held in Pittsburg, June 4, 1889.

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KNOWLEDGE, like the hard woods, is of slow growth. Auenbrugger worked seven years upon that discovery which he gave to an unheeding profession as the "Inventum Novum." Half a century later it was rescued from oblivion by Corvisart, to be extended and perfected in another quarter of a century by Piorry. Laennec had already acquired a reputation by his practice and writings, when, in 1815, he invented the stethoscope. Four years later he published his *Treatise upon Mediate Auscultation and the Diseases of the Lungs and Heart*, but almost a quarter of a century elapsed before this method of clinical investigation became popularized among medical men, and was generally taught in the schools of England and America. Jenner spent nearly twenty years in investigations and experiment before he published, in 1798, his *Enquiry* into the causes and effects of the cow-pox.

Yet each of these discoveries revolutionized that department of the art of medicine which it affected, and to-day no student is entitled to receive the degree, which marks his admission to the profession, who does not know more of percussion than Auenbrugger, at least as much of the principles which underlie auscultation as Laennec, and unless he has easily acquired the essential facts of that beneficent discovery which cost Jenner twenty years of toil.

These things were in the old days. We live, if not in an era of more impatient intellectual activity and keener

inquiry, at least in a time of the infinitely more rapid dissemination of information. A flash of electricity, a turn of the press, and that which happened yesterday is known all over the civilized world. But this is news, not knowledge.

Lister's memorable introductory lecture in the University of Edinburgh on "the germ theory of putrefaction, the basis of a new mode of treatment which finds its application in all departments of practice," was delivered in the autumn of 1869. It makes a little pamphlet of twenty-two pages. The time was ripe for the principles set forth in that publication, and in others which quickly followed it. Much that had gone before led up to them. We think at once of the work of Latour, of Schwann, of Pasteur. The facts were convincing. Many of the details of Lister's early methods were, it is true, unnecessary, some were faulty; but the underlying thought was right. If not a new truth, it was certainly a new application of truth.

Nearly twenty years have elapsed, and the seed sown by Lister has grown and multiplied and brought forth an abundant harvest. The surgery of to-day stands in bright contrast to the surgery of that day. The antiseptic procedure has enormously widened its scope and increased its precision. Its capacity to relieve suffering and prolong life is abundantly enlarged. The contrast is so striking that it has become customary to speak of the art of to-day as the New Surgery.

This revolution was not brought about in a day. Listerism and the operative technique which it inspired, made for a long time slow and halting progress. Prejudices were to be overcome, old habits of thought given up, the traditions abandoned, and it was only little by little, notwithstanding the readiness of inter-communication and the eagerness for new and better things which characterize the present, that the New Surgery came into being.

Koch, who had previously published a paper entitled "Investigations into the Etiology of the Traumatic Infective Diseases," announced his discovery of the tubercle bacillus and its relation to tuberculosis in March, 1882. As an example of scientific research, this work stand unequalled in the history of medicine. Had it led to no practical results, its thoroughness, the logical sequence of the various progressive stages of the investigation, its completeness, the rigid tests to which he subjected his results, make it a model for investigators in every department of biology.

Koch demands, in order to determine whether or not

a given bacterium is the cause of a certain disease, the fulfilment of the following requirements:

(*a*) The special bacterium must be present in all cases of the disease.

(*b*) It must be separated from other microörganisms, and from all matter found with it in the diseased animal.

(*c*) Thus freed from all foreign matter, it must be capable, when properly introduced, of producing the disease in healthy animals.

(*d*) The bacterium must be found properly distributed in the animal in which the disease has been induced.

Not only did he devise and elaborate the technical methods by which these rules can be carried out, but he saw that every one of the conditions was absolutely fulfiled in the investigation which he had undertaken. The proof was final; the demonstration complete. The germ theory was no longer a working hypothesis; it had become, in regard to the tuberculous diseases at least, an incontrovertible fact. So admirable was Koch's account of his investigation, that Trudeau, in the Adirondacks, with but little knowledge of microscopy and very imperfect apparatus, much of which he constructed himself, was enabled by following a translation of the original report to repeat the research step by step, and verify the results by the inoculation of pure cultures of the bacillus.

The labors of Lister had not only made the discovery of special pathogenic microörganisms possible; they had made it a necessity. There were many workers in the field; the fulness of time had come. Obermeier had already in 1873 discovered the spirillum of relapsing fever. Had it not been the tubercle bacillus, some other pathogenic bacterium would have been brought to light in its causal relationship to some specific morbid process. But to Koch is due the lasting honor of having first clearly demonstrated the part played by microörganisms in the etiology of disease, and of having thus laid the foundation of the science of bacteriology.

This discovery, modestly as it had been announced by its author, was at once heralded throughout the world and received with acclamation. Klebs, Cohnheim, and others had already, without reserve, placed tuberculosis in the group of the specific infectious diseases. To have found the infecting principle itself, or at all events the carrier of the infection, seemed a boon almost beyond comprehension. Its importance appealed to the dullest attention. The mortality statistics of pulmonary consumption are, unfortunately, too familiar. To this disease alone fifteen per cent. of all deaths are to be attributed. Add to these the deaths due to tuberculosis of

other organs, of the joints, of the meninges, of the peritoneum, then swell the list by the cases cut off by intercurrent diseases or accident, and the result is simply appalling. The tuberculous diseases are not endemic the world over, they are epidemic. Consider that a large proportion of the cases are chronic, progressive, inexorably disabling, and it becomes easy to realize that this group of diseases exerts an influence upon the family and upon society that nothing but the apathy begotten of hopeless familiarity renders endurable. It is easy then to understand the enthusiasm with which Koch's discovery was received. Men thought of the maxim *Causa sublata tollitur effectus.*

The cause being now found, nothing seemed easier than that it should be dealt with, and that, as a consequence, one great scourge of the human race would become preventable, if not curable. Certainly, one of the first effects was to arouse both the profession and the people from the apathy into which they had fallen in regard to these diseases. Those who had the opportunity and training proceeded to verify and extend Koch's investigations, with the result, not only of acquiring a mass of information in regard to the life-history of the bacillus itself, and a more exact knowledge of the pathology of the tuberculous diseases, but also with the acquisition of like knowledge in regard to other bacteria, and the part played by them in the pathogenesis of many other infections.

Others turned their attention without delay to therapeutic investigations, having for their object the destruction of the tubercle bacillus. It is needless to enumerate the methods of antiseptic and germicide treatment which have been the outcome of these efforts. They are fresh in your memory. Based upon insufficient knowledge of the mode of growth and development of the tubercle bacillus in the tissues, they have one after another been tried and found wanting.

These failures have afforded an apparent justification to that contingent of the profession who, preferring darkness to light, because the light has not yet flooded all the obscure places, still refuse to recognize the etiological relationship between the tubercle bacillus and tuberculosis.

Seven years have now passed. A host of workers have collected a vast array of facts which rest upon a sure basis of truth. These facts are being sorted and placed in proper relation with each other. A critical observer sees that steady progress is being made. In surgery much has been accomplished; yet the results in

the diminution and cure of the visceral tuberculous diseases are not encouraging. The growth of knowledge is slow; it is not the less sure. He does not to-day seem too sanguine who looks forward to practical results of the greatest importance, if not in the cure, at least in the prevention, of pulmonary consumption.

Some broad generalizations are already possible:

1. *Tuberculosis is a specific infectious disease.*

Its exciting cause is the tubercle bacillus. Its etiology is the natural history of that parasite. The predisposing influences are those conditions, both inherited and acquired, which favor the implantation and growth of the bacillus. Its pathology is summed up in the statement of the facts which relate to the development of the bacillus in the tissues, and the effects which it produces locally and upon the organism at large. Its diagnosis no longer depends upon the anatomical character of the lesions, but upon the presence of the tubercle bacillus and upon its inoculability.

The distinction between true tubercle and pseudo-tubercle is now perfectly clear. Both these formations are composed chiefly of lymphoid corpuscles or leucocytes. They are the result of an irritative hyperplasia. But the tubercle is the result of a chronic or persistent inflammation produced by a continuously acting irritant, and spreading by the infection of neighboring parts and by the circulation. The pseudo-tubercle may be produced by the mechanical irritation of small foreign particles. It constitutes, upon the subsidence of the active process, simply a mass of fibrous tissue, which undergoes no further change, and it remains single, being without the power of giving rise to other similar structures.

The pathological unity of the tuberculous process, whatever the tissue or organ affected, however diverse the clinical manifestations, is at once established by the double test of the presence of the bacillus and the inoculability of the disease. The relationship between the most unlike lesions subjected to these tests becomes apparent. The lung packed with tubercle or riddled with cavities owes its lesions to the same cause which produces the insignificant tuberculous wart upon the hand of the pathologist who dissects it; intestinal ulceration, hyperplasia of the mesenteric glands, peritonitis, fistula in ano, may all result from the action of a common cause.

The pathological identity of processes producing the most diverse lesions in the same organ is also shown by these tests. So-called chronic catarrhal pneumonia of the apex, gray miliary tubercle, diffuse, tuberculous, cheesy infiltration in the lungs, are dissimilar manifesta-

tions of the same pathological process. Joseph Coats maintains the view that the changes of fibroid phthisis are essentially tuberculous. The "solitary tubercle" of the brain, which is usually yellow and caseated, and may be as large as a walnut, is due to the same cause as the miliary tubercles occasionally found scattered in other parts of the brain substance and so familiar in the meninges.

A large proportion of the cases called scrofulous are now known to be tuberculous. We no longer think that scrofulous individuals are especially liable to become tuberculous, for tubercle bacilli are almost constantly found in so-called scrofulous lymph-glands, bones, and joints. After a time the local tuberculosis becomes extended or generalized.

Neelsen places tuberculosis along with enteric fever, leprosy, and syphilis in his fourth group of the germ diseases—namely, the mycoses with tissue proliferation or infected ulcers.

2. *The constitutional manifestations are not directly due to the bacilli, but to toxic principles evolved during their growth and multiplication.*

The bacteriologico-chemical researches of Hoffa, Brieger, Vaughan, and others, within the past few years, have done much to clear up the relation between the special pathogenic germs of the infectious diseases and their symptomatology. They have also rendered necessary a new definition of the infectious diseases. In the words of Vaughan and Novy, "An infectious disease arises when a specific, pathogenic microörganism, having gained admittance to the body, and having found the conditions favorable, grows and multiplies, and in so doing elaborates a chemical poison which induces its characteristic effects."

Nencki obtained upon chemical analysis of tubercle bacilli, water 88.82 per cent., solids 11.18 per cent. The solids yielded 22.7 per cent. of substances soluble in alcohol and ether, which, when used experimentally upon animals, showed the presence of a tetanizing poison. This substance has not been isolated. Bonardi demonstrated in tuberculous sputum alkaloidal organic bases, which introduced into rats and guinea-pigs rapidly produced remarkable disturbances of the nervous system. This experimenter believes that these organic bases may explain the fever, sweating, disturbance of the circulation, and other general symptoms of the disease.

The wide range of intensity in the constitutional phenomena is to be explained, only in part, by the varying

reaction of different individuals to morbific agencies. It is more largely due to the extent and activity of the local process. Nor can we attribute the constitutional disturbances to suppuration associated with local tuberculous processes, as in the case of the breaking down of pulmonary infiltrations, or in joint diseases; for constitutional disturbances of the same kind, and of every degree of intensity, are developed in tuberculous meningitis, tuberculous peritonitis, and in those rapidly developing cases of consumption in which the lungs are found studded with miliary tubercle without extensive caseation or suppuration. Furthermore, decided constitutional disturbances are not infrequently associated with circumscribed lesions of insignificant extent, while enormous cavities, occupying the large portion of a lobe, are not incompatible with fair nutrition and moderate health for a period of years, in cases in which, after extensive destruction, the tuberculous process, as such, has come to an end.

Finally, the frequency with which obsolescent tuberculous lesions at the apex of a lung are found in individuals dying late in life from non-tuberculous diseases, suggests the possibility that a tuberculous process, terminating in resolution, may confer upon the individual in whom it has occurred subsequent immunity from the disease. The very lesions show that such individuals have at one period of life been susceptible, while their repeated exposure to the infecting principle during subsequent periods may be fairly assumed.

3. *Tuberculosis is directly and indirectly communicable from the affected to the healthy individual.*

In other words, it is a contagious disease. Koch has demonstrated the fact that tubercle bacilli never develop or multiply outside of the body of animals. They require for their development a constant and uniform temperature of 85° to 100°; they, however, retain their vitality for an indefinite period outside of the body and under conditions extremely unfavorable for the development of other microbes.

Cadéac and Malet found that tuberculous matter dried and pulverized was, after one hundred and two days, capable of giving rise to the disease. Schill and Fischer maintain that it only loses its virulence after six months. Pietro asserts that well-dried sputum may retain its infecting power for nine or ten months if maintained at a temperature of 77° F. Bacilli with or without spores show an equal tenacity of life. The distribution of tubercle bacilli outside of the body is, however, by no means as extensive as was formerly thought. The in-

vestigations of Cornet prove conclusively that they are to be found in greatest numbers in the immediate neighborhood of affected individuals; that they are not found in the dust collected from the abodes of individuals free from consumption, nor are they to be found in the apartments occupied by consumptives who habitually and exclusively use the spit-cup.

The experimental production of tuberculous diseases by the inoculation of sputum or other substances containing tubercle bacilli is a familiar fact. When animals thus inoculated are killed in a short time, the lesions are invariably found restricted to the point of inoculation and the neighboring lymph-glands. In view of this fact, Cornet holds that the assumption that the lungs are the seat of an especial predilection for the development of the tuberculous process is absolutely untenable, the frequency of pulmonary consumption, as compared with other forms of tuberculous disease, being due to the favorable conditions presented by the respiratory organs for the implantation of the infecting material. Numerous experimenters have shown that air passing over moist surfaces is incapable of taking up tubercle bacilli; the expired air which passes over the moist surfaces of the respiratory tract, of cavities, of collections of bacilli-containing pus or muco-pus not yet expectorated, does not carry the infecting principle, and is, therefore, incapable of communicating the disease.

Nor do the expectorated matters themselves, so long as they remain moist, comply with the conditions necessary for the communication of the disease to healthy individuals except by direct contact or inoculation. When dried, however, they are capable of dissemination through the atmosphere in the form of fine dust bearing bacilli and spores, which, being inhaled by susceptible individuals, cause the disease. Desiccation is a necessary requirement for the dissemination of tubercle bacilli and spores by means of the atmosphere, and the most favorable conditions for such dissemination are found within doors. Wet weather and a moist atmosphere are unfavorable.

The fact that the disease is most frequent in crowded quarters supports the view of dissemination by means of dried sputum. Flick, in his remarkable investigations in Philadelphia, found that ninety per cent. of infected houses had an infected house joining them, while thirty-three per cent. of the infected houses showed more than one case. These facts warrant the conclusion that consumption is communicated by contact, by association, or by living in close proximity.

Flick also found that pulmonary phthisis conformed

to the laws which govern the spread of contagious diseases in other respects. The grouping of the cases is the same, and the localization is influenced by the age of those predisposed to the disease. It prevails in circumscribed epidemics, which are, however, less noticeable because the disease is of long duration, whereas the ordinary contagious diseases run their course rapidly.

From this point of view, the gradual infection of several members of a household, previously free from the disease, in the course of a few months or years after the introduction of a case, becomes intelligible. So, also, married couples infect each other; and those who nurse relatives suffer from the disease, females being more liable by reason of their closer ministration. Leibermeister has observed many cases where previously healthy families became infected one after another after removal to a house formerly occupied by a consumptive patient.

It is, however, a question of the seed and the soil. A large proportion of individuals enjoy an immunity which appears to be complete; many others, while capable of infection, show a remarkable resistance to the invasion of the tuberculous process which either undergoes resolution in the region infected or makes a tardy progress interrupted by more or less prolonged periods of quiescence. Between cases of this form and the cases called *phthisis florida*, the disease manifests every degree of intensity.

These variations in the degree of susceptibility to the disease and its development serve to explain some of the objections which have been urged with more or less force against the doctrine of the contagiousness of pulmonary consumption.

Those who assert that if consumption were contagious the human race would have rapidly become extinct, overlook the fact that a considerable number of persons in every community, especially those living outdoor lives, and those who are not brought into association with consumptives in confined apartments, are not exposed; and, secondly, the fact that a certain proportion of individuals, either by reason of the resistant power of their tissues, or of the integrity of the mucous surfaces of the air-passages, or from other causes not well understood, possess a more or less complete immunity. Those who deny the contagiousness of phthisis on account of the infrequency with which medical men, nurses, and other attendants upon consumptives are said to contract it, advance an argument which rests upon insufficient grounds. A certain proportion of individuals thus brought into habitual contact with consumptives enjoy an immunity; others while susceptible doubtless escape

infection by reason of the thorough ventilation and cleanliness of well-regulated wards and sick-rooms. Physicians and attendants upon those suffering from cholera or the fevers, even in hospitals in which considerable numbers of such patients are collected, do not often contract the disease, yet who will deny that according to their special modes of transmission, cholera, enteric fever, and typhus are contagious?

Another difficulty lies in the localization of the tuberculous process in its beginning, and its tardy development, the time which elapses from the infection and the manifestation of the disease being not infrequently so long that the original exposure, even when traceable, is forgotten.

The often quoted statement of Williams in regard to the exemption of nurses and attendants in the consumptive hospital at Brompton is valueless in the light of advancing knowledge. The cleanliness and ventilation of a well-ordered hospital tend to reduce the dangers of infection. The statistics of Baer and others show a mortality in prisons that is nearly four times as great as outside, the majority of cases developing not during the earlier years of imprisonment but toward its close. The fact that more than fifty per cent. of nuns in cloisters die of tuberculosis speaks for itself.

The attendants in hospitals come and go; many of them remain in the service for short periods only. The statistics of Williams are incomplete in not showing the subsequent history of the personelle upon which they are based. On the other hand, the elaborate recent statistics of Cornet prove incontestably that attendants upon the sick show as a class an enormously increased death-rate, the increase being due to tuberculosis and other infectious diseases.

4. *It is not in the ordinary sense hereditary.*

Prior to the discovery of the tubercle bacillus, the direct transmission of tuberculosis from the parent to the child was very often assumed. The frequency with which the children of consumptive parents were affected with the disease was regarded as proof of its transmission by inheritance. Even tuberculosis developing in adult life in those previously presenting every appearance of health, was assumed to be of hereditary origin, the frequent absence of tuberculosis in the parents notwithstanding, for it was assumed that hereditary tuberculosis might skip a generation or two.

Baumgarten supports the view that congenital tuberculosis may be latent, the bacilli remaining inactive in certain tissues for years, or throughout life, unless called into activity by traumatism or other influences.

The number of cases in which tubercles have been actually found in the fœtus is very small. The view that congenital tuberculosis may be due to the semen or ovum, is a pure hypothesis unsupported by proof. The opinion that it may be derived from the maternal blood by way of the placenta, rests upon a small number of positive facts. Malvoz found that microörganisms may pass the placenta only when it is diseased. Charrin found in a seven and a half months fœtus of a tuberculous woman, which died three days after birth, tuberculous lesions of the abdominal organs. Merkel discovered cheesy nodules in the palatine arch, the lymph-glands, and in the neighborhood of the hip-joint, but not in the lungs of a child of a tuberculous woman, which died directly after birth.

Should the view held by Baumgarten be proved, it will explain the presence of tubercle in the lymph-glands, bones, and marrow, and the occurrence of tuberculous meningitis, which is so common in young children. Even in very young children, the primary infection frequently takes place by way of the lungs, a fact fully in accord with what is now known of the mode of contagion, the relation between the mother or nurse and the young baby affording the fullest opportunity for the communication of the disease.

The conclusion that enteric fever or scarlet fever is hereditary, would rest upon very nearly the same basis of fact upon which the doctrine of the hereditary transmission of tuberculosis has been assumed, namely, that the parents of those having the sediseases had previously suffered from them, and that, in a few rare instances, the child of an infected mother has shown the characteristic signs at birth.

In regard to the hereditary transmission of tuberculosis among the domestic animals, the statistics of the Berlin abattoir are not without interest. Among 320,000 calves, 17 were tuberculous; whereas, among 398,000 cattle, there were no less than 8000 tuberculous.

5. *A rational, scientific prophylaxis is practicable both as regards individuals and communities.*

The part played by heredity in direct distribution and propagation of the tuberculous diseases is insignificant as compared with the influence of contagion. The few children of tuberculous parents born tuberculous have died promptly; those who develop the disease in infancy, die early in life; the infected children of tuberculous parents who reach adult age are those who long suffer only from tuberculous diseases of the lymph-glands and the bones, and are not, in the absence of pulmonary lesions, likely to disseminate the infecting material.

The chief avenues of infection are the digestive and

respiratory tracts. The disease is acquired by infected food, and by the inhalation of air containing tubercle bacilli and spores; other methods of invasion are infrequent and relatively unimportant.

The only sources of the infecting material are those discharges from the bodies of infected human beings and domestic animals which contain the tubercle bacilli and their spores. Of these, the chief are cow's milk used as food, and the matters expectorated by patients suffering from pulmonary phthisis, which is not likely to infect unless dried and inhaled as dust. The flesh of tuberculous cattle does not cause tuberculous diseases in those who partake of it; there is, in fact, no case on record of the communication of the disease by these means. The liability of its communication by milk is increased where there is tuberculous inflammation of the udders of the cows. It is important, therefore, that all milk used as the food of infants should be sterilized by boiling, and until used it should be kept protected from the atmosphere.

The infection by way of the intestinal tract, frequent as it is, especially in childhood, is notably less common than infection by way of the respiratory surfaces.

As Cornet has shown, the only effectual prophylaxis is in the proper care of the sputum. In this respect tuberculosis presents a strong analogy to enteric fever, of which it has been said, "that measures of prophylaxis will be efficient in proportion to the strength of our belief in the material nature of the typhoid poison, and in the possibility of destroying it or preventing its spread." It is the duty of the physician to see to it that no case of infectious disease under his care becomes a focus of contagion. In enteric fever we have long recognized a disease in which this rule can be effectively carried out by means of the disinfection of the stools. It is evident that in pulmonary phthisis we must follow the same principle of prophylaxis, the one efficient procedure being the proper disposition of the bacilli-laden expectoration.

The difficulties in the practical application of this rule lie, on the one hand, in the chronic nature of a large proportion of the cases of the disease, and, on the other, in the deeply rooted prejudices or indifference of patients in regard to the matter. Cornet has formulated the rule that a phthisical patient should never under any circumstances expectorate on the floor or in a handkerchief, but always in a spitcup; this is the one thing needful. The cup should contain a little water, and be frequently emptied into the sewer, where the contents sooner or later undergo destruction, or at all events pass beyond the reach of inhalation by man. The cup should be frequently washed with boiling water. A cup has recently

been devised, and is sold in the shops in this country, which consists of a small metal frame in which a folded paper cup is set; when a quantity of sputum has accumulated, the paper may be removed and burned with its contents.

The floor should be sprinkled with water before sweeping, and the sweepings destroyed by burning. The clothing and bedding of tuberculous patients should be disinfected by prolonged boiling. The walls of apartments occupied by patients should be frequently rubbed down with bread, which may then be burned. Carpets and curtains should be shaken in the open air at a distance from houses, and exposed at intervals to the air and sun.

The acceptance and universal practice of prophylactic measures would warrant the hope that the prevalence of pulmonary consumption will diminish, as have the septic diseases following surgical operations and puerperal fever, under a rational prophylaxis.

Such a result is not only theoretically possible; its accomplishment in the course of time is, in a high degree, probable. This hope has the support of strong analogies in the records of the past; the great scourges of mankind have prevailed during more or less extended historical epochs, and then passed away. The plague which ravaged all parts of Europe during the Middle Ages, which depopulated villages and laid waste districts, which, in the form of the black death, swept over Europe in the fourteenth century, and destroped in three years twenty-five millions of inhabitants, disappeared from England with the great outbreak of 1665. Only twice during the present century has this pest shown itself in Western Europe. The disappearance of the plague was probably due to the conjoint influence of a rigorous quarantine and altered methods of living. It has been said in regard to Europe, that when the shirt came in, the plague went out.

Typhus, which devastated Europe from the fifteenth century until the end of the first quarter of the present century, of which Murchison says, "A complete history of typhus would be the history of Europe for the last three and a half centuries," has almost burnt itself out. Here and there in the seaport cities of Great Britain it still smoulders, but in the great modern campaigns of the American War and the Franco-Prussian War typhus fever was unknown. Its disappearance is unquestionably due to that prophylaxis which comes of a clear knowledge of its causes, and to the improved hygiene of modern life.

Leprosy was for thirteen centuries endemic in Great

Britain; cases were still in existence on the borders of Scotland toward the close of the last century. To-day no indigenous case is to be found within the British Isles.

Smallpox was for centuries one of the greatest scourges of mankind. Scarcely a decade passed in which the disease, sweeping over great areas, did not decimate the inhabitants of one country or another. To-day we have no dread of it beyond the fear lest prolonged and complete immunity may beget neglect of the precautions which protect us.

The discovery of the tubercle bacillus has not been without practical results. Without it these generalizations were impossible. It has given us, in place of obscurity, confusion, uncertainty in regard to pulmonary consumption and the other tuberculous diseases, a positive etiology, a clear pathology, a rational therapeutics, a hopeful prophylaxis. These are great gains at the end of seven years.

But it has done more than this. It has pointed out the direction of future work, and indicated possibilities never before dreamt of. The news of Koch's discovery burst upon the world like a flash that grew faint, leaving the eyes dazzled. The knowledge which Koch has given us is like the dawn, which steadily grows brighter and brighter, until the clear day shows the perfect truth.

How shall we fitly characterize those rare men who, by sheer intellectual force, have found and given to their fellowmen new truths? By what metaphor shall we make their greatness plain? They are bright stars—suns—in the intellectual firmament, in the steady light of whose genius the work of mankind may be carried on as in the open day. I speak not of science in general, nor for the other sciences, but in medicine a century has given us five—that son of France, dead at thirty-one, whose philosophic mind conceived those generalizations which laid the foundation, not only for modern physiology, but for modern biology; that German, no longer young, to whom nothing human is without interest, busy in the affairs of men to-day as always, both in science and in politics, whose labors laid the foundation for the science of modern pathology; that Englishman, to whose clear insight mankind for nearly a century past, and for all time to come, owes the incalculable boon of deliverance from smallpox; that other Englishman, who to-day lives to see in the result of his labors the new surgery; and, lastly, him to whom we owe that discovery upon which rests the young science of bacteriology—they are called—names never to be forgotten!—Bichat, Virchow, Jenner, Lister, Koch.